A COMPARISON OF RIGHT AND LEFT SIDED INTERNAL JUGULAR VENOUS CANNULATION BY THE TRADITIONAL BLIND ANATOMIC LANDMARK TECHNIQUE

DISSERTATION SUBMITTED TO

THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY

in partial fulfillment for the award of the degree of

DOCTOR OF MEDICINE

IN

ANAESTHESIOLOGY

BRANCH X

DEPARTMENT OF ANAESTHESIOLOGY

MADRAS MEDICAL COLLEGE

CHENNAI - 600 003.

MARCH 2008

CERTIFICATE

This is to certify that the dissertation entitled, **"A COMPARISON OF RIGHT AND LEFT SIDED INTERNAL JUGULAR VENOUS CANNULATION BY THE TRADITIONAL BLIND ANATOMIC LANDMARK TECHNIQUE"** submitted by Dr.Ashok Kumar. A, in partial fulfillment for the award of the degree of Doctor of Medicine in Anaesthesiology by the Tamilnadu Dr.M.G.R. Medical University, Chennai is a bonafide record of the work done by him in the Department of Anaesthesiology , Madras Medical College, during the academic year 2005 – 2008.

DR.T.P.KALANITI, M.D.,

DEAN,

MADRAS MEDICAL COLLEGE &

GOVT. GENERAL HOSPITAL,

CHENNAI – 600 003.

PROF.S.GAYATHRI, M.D., D.A

PROFESSOR & H.O.D,

DEPT OF ANAESTHESIOLOGY,

MADRAS MEDICAL COLLEGE,

CHENNAI – 600 003.

ACKNOWLEDGEMENT

I am extremely thankful to **Dr.T.P.Kalaniti, M.D**., Dean, Madras Medical College, for his kind permission to carry out this study.

I am immensely grateful to **Prof. Dr.S.Gayathri , M.D.,D.A**., Professor and Head of the Department, Department of Anaesthesiology, for her concern and support in conducting this study.

I am very grateful to **Dr.Kamalini Sridharan , M.D.,D.A**., Additional Professor of Speciality Services, **Dr.C.R.Kanyakumari, M.D.,D.A**., Additional Professor of Cardiothoracic Anaesthesia, for their constant motivation and valuable suggestions.

I am thankful to **Dr.T.Venkatachalam, M.D., D.A**., Registrar, Department of Anaesthesiology, for his suggestions in making this work complete.

I am greatly indebted to my guide **Dr.R.Shanthi Malar, M.D.,D.A.,**for her inspiration, guidance and comments at all stages of this study.

I am thankful to all assistant professors for their guidance and help. I am thankful to all my colleagues for the help rendered in carrying out this dissertation.

I am thankful to **Dr. Jayalakshmi M.D.,**for her help in analysis of data.

Last, but not the least, I thank all the patients for willingly submitting themselves for this study.

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INTRODUCTION

Central Venous access is essential part of patient management in many clinical settings. Central Venous catheters are used for hemodynamic monitoring, giving vasopressors, cytotoxic drugs, blood sampling and transfusion of blood products, preoperative intravenous fluid infusion and parenteral nutrition [(1)].

Central Venous cannulation is performed in a wide range of locations within the hospital as an elective or emergency procedure. Central Venous access is commonly attempted at the internal jugular vein, subclavian vein, femoral vein or arm veins using peripherally inserted central catheters. The actual site chosen in a particular patient should vary based on the indication, individual institutional and operator experiences. In most preoperative patients, IJV is the best route because of it's reliability and low rate of major complications with insertion.

There are various techniques for placing central venous catheters in IJV. The standard conventional technique for placing central venous catheters in IJV is by using anatomical landmarks[(1)]. The right internal jugular vein is usually chosen for many reasons. But, in cases like

penetrating injuries on the left side of chest, left side hydropneumothorax, etc., left internal jugular venous cannulation is preferable.

The anatomical relations, course dimensions of left internal jugular vein differ from right internal jugular vein. Hence it is very important to compare the success rate, complications and depth of right and left internal jugular venous cannulation.

AIMS OF THE STUDY

The purpose of this study was to compare right and left internal jugular venous cannulation by traditional blind anatomic landmark technique for placement of central venous catheter in patients posted for major elective cardiac surgeries in terms of the following parameters:

1. The time taken to locate the IJV with pilot needle,
2. The time taken to locate the IJV with 18 G needle,
3. Number of attempts required for successful guide wire insertion,
4. Depth of cannulation,
5. The total access time,
6. The success rate and failure rate and
7. Incidence of complications.

HISTORICAL PERSPECTIVE

- 1952 – Aubaniac[1] gave the first description of infraclavicular subclavian venipuncture in humans.
- 1953 – Seldinger[2] described the replacement of a catheter needle using a guidewire during central venous cannulation.
- 1955 – Percutaneous catheterization of the inferior vena cava via the femoral vein approach became popular until reports of a high incidence of complications were published[3,4].
- 1959 – Hughes and Magovern[5] described the clinical use of central venous pressure measurements in humans undergoing thoracotomy.
- 1962 – Wilson and associates[6] extended the practicality of central venous pressure monitoring by using percutaneous infraclavicular subclavian vein catheterization.
- 1962 – Yoffa[7] reported his experience with supraclavicular subclavian venipuncture, claiming a lower incidence of complication, but his results were not uniformly reproduced.
- 1962 – Nordlund and Thoren[8] and then Rams and associates[9] performed external jugular vein catheterization with fewer complications but positioning of catheter tip in a central venous location was sometimes impossible.

- 1966 – Hermosura and colleagues[10] described the technique IJV cannulation and advocated it's use in adults.
- 1969 – English et al[11,12], reported the first large series (500 cases) of IJV cannulations. Subsequently the procedure became more common and in many centres the preferred method of central venous access.
- 1974 – Blitt et al[13], described a technique of Central Venous cannulation via the EJV employing a J wire. Although the success rate of this route is lower than with the IJV, a Central Venipuncture is avoided, and in selected cases catheterization via the EJV is an excellent alternative.
- 1984 – Legler and Nugent[14] first reported the use of ultrasound to assist IJV cannulation in the anaesthesiology literature.

ANATOMY OF THE INTERNAL JUGULAR VEIN

The internal jugular vein collects the blood from the skull, brain, superficial parts of face and much of the neck. It begins at the cranial base in the posterior compartment of the jugular foramen, continuous with the sigmoid sinus. At the origin is its superior bulb, which is below the posterior part of the tympanic floor. The vein descends in the carotid sheath, uniting with the subclavian, posterior to the sternal end of the clavicle to form the brachiocephalic vien. It is also dilated near its end as its inferior bulb, above which it contain a pair of valves. Posterior to the vein from above are: The rectus capitis lateralis, transverse process of atlas, levator scapulae, scalenus medius and the cervical plexus, scalenus anterior, phrenic nerve, thyrocervical trunk, vertebral vein and first part of subclavian artery; on the left it also crosses anterior to the thoracic duct. Medial to the vein are the internal and common carotid arteries and the vagus nerve between vein and arteries but posterior to them. Superficially the vein is overlapped above, then covered below by sternocleidomastoid and crossed by the posterior belly of digastric, and the superior belly of omohyoid. Superior to the digastric, the parotid gland and the styloid process are superficial, the accessory nerve, posterior auricular and occipital arteries crossing the vein. Between the digastric and the omohyoid, sternocleidomastoid arteries and inferior root

of ansa cervicalis cross it, but the nerve often passes between the vein and the common carotid. Below the omohyoid it is crossed by the anterior jugular vein. Deep cervical lymph nodes lie among the vein, mainly on its superficial aspect. At the root of the neck, the right IJV is separated from the common carotid but the left IJV usually overlaps its artery. At the base of the skull the internal carotid artery is anterior, separated from the vein by ninth to twelth cranial nerves. The junction of the right subclavian vein and then the innominate vein forms a straight path to the SVC. As a result, malpositions and looping of a catheter inserted through the right IJV are unusual. In contrast, a catheter passed through the left IJV must negotiate a sharp turn at the left jugulosubclavian junction, which results in a greater percentage of catheter malpostions[15]. This sharp turn may also produce tension and torque at the catheter tip, resulting in a higher incidence of vessel erosion[16,17]. Knowledge of structures neighbouring the IJV is essential, because they may be invaded by a misdirected needle.

Surface Anatomy

IJV is marked as a broad line made by joining the two points as mentioned below.

a. The first point is on the neck, medial to lobule of the ear.

b. The second point is at the medial end of the clavicle.

The lower bulb of the vein lies beneath the lesser supraclavicular fossa between the sternal and clavicular heads of the sternocleidomastoid muscle.

Tributaries

The inferior petrosal sinus, facial, lingual, pharyngeal, superior and middle thyroid veins sometimes the occipital. It may communicate with the external jugular vein. The thoracic duct opens near the union of left subclavian and internal jugular veins; the right lymphatic duct is at the same site on the right.

TECHNIQUES OF IJV CANNULATION

Internal jugular venipuncture may be accomplished by a variety of methods. All methods use the same landmarks but differ in the site of venipuncture or orientation of the needle. There are three general approaches[18].

1. Central approach
2. Anterior approach
3. Posterior approach

The method chosen varies with the institution and the operator's experience. All approaches require identical equipment, and the operator may choose from many different catheters and prepackaged kits.

1. Central Approach[12,18-22]

This approach described by Daily and colleagues[20] is the most popular technique. Skin puncture is at the apex of the triangle formed by two muscle bellies of sternocleidomastoid muscle and the clavicle. The ICA pulsation is usually felt 1 to 2cm medial to this point, beneath or just medial to the sternal head of the muscle. The skin at the apex of the triangle is infiltrated with 1 % lignocaine using 22 G needle, which is then used to locate the IJV. Use of a small bore finder needle to locate the

IJV should prevent inadvertent ICA puncture and unnecessary probing with a large bore needle. The operator should maintain slight or no pressure on the ICA with the left hand and insert the finder needle with the right hand at the apex of the triangle (slightly caudal) at a 30-45 degree angle with the frontal plane, directed at the ipsilateral nipple. After expulsion of any skin plug the needle is advanced steadily with constant back pressure and venipuncture occurs within 3-5cm. Deeper penetration is not recommended. If venipuncture does not occurs on the initial thrust, back pressure should be maintained and the needle slowly withdrawn, as venipuncture frequently occurs on withdrawal. If first attempt is unsuccessful the operator should reassess the patient position, land marks and techniques to ensure that he or she is not doing anything to decrease IJV lumen size. Subsequent attempts may be directed slightly laterally or medially to the initial thrust , as long as the place of the ICA in not violated. If venipuncture does not occur after three to five attempts, further attempts, are unlikely to be successful and only increase complications[22,23,24].

When venipuncture has occurred with finder needle, the operator can either withdraw the finder needle, and introduce the large bore needle in the identical plane or leave the finder needle in place and introduce the larger needle directly above it . If using the latter technique, the operator

or assistant must be careful not to exert torsion on the finder needle, as this may decrease the lumen size of IJV and the 18G thin wall needle, the operator must be sure to secure the needle in place with one hand while removing the finger with the other, so that the needle does not migrate out of the vein prior to guidewire insertion. Once venipuncture has occurred the syringe is removed during expiration or valsalva maneuver and the hub occluded with a finger after ensuring that the backflow of blood is not pulsatile . The j-tip of guide wire is then inserted and should pass freely up to 20cm, at which point the thin wall needle is withdrawn. The tendency to insert the guidewire deeper than 15 to 20cm should be avoided, as it is the most common cause of ventricular arrythmias during insertion and also the guide wire does not pass easily beyond the tip of thin wall needle. The guide wire should then be withdrawn, the syringe attached, and free backflow of blood reestablished and maintained while the syringe and the needle are brought to a more parallel plane with the vein. The guide wire should then pass easily. If resistance is still encountered, rotation of guide wire during insertion often allows passage, but extensive manipulation and force only leads to complications. With guidewire in place, a scalpel is used to make two generous 90-degree stab incisions at the skin entry side to facilitate passage of vessel dilator. The dilator is inserted down the wire to the hub, ensuring that control and facility of the guide wire is not compromised. The dilator is then

withdrawn and gauze used at the puncture site to control oozing and prevent air embolism down the needle tract. The triple lumen catheter is then inserted over the guidewire ensuring that the guidewire protrudes from the distal lumen hub before the catheter tip penetrates the skin. The catheter is then advanced 15 to 17 cm into the vein, the guide wire withdrawn, and the distal lumen capped. The catheter is sutured securely to limit tip migration and bandaged in a standard manner.

A chest radiograph should be obtained to detect complications and tip location. Central venous catheters placed in the operating room are generally used for the duration of surgical procedure without first confirming the location of the catheter tip radiographically. After surgery, however, the position of the catherter tip must always be confirmed radiographically.

2. Anterior Approach [18,25,26,27]

This approach differs in the venipuncture site and plane of insertion. The important landmark is the midpoint of the sternal head of the sternocleidomastoid muscle, approximately, 5cm from both the angle of mandible and sternum. At this point, the carotid artery can be palpated 1cm inside the lateral border of the sternal head. With the index and middle finger gently palpate the artery, and the needle is introduced 0.5 to 1 cm lateral to the pulsation. The needle should form a 30-45 degree angle with the frontal plane and be directed caudally parallel to the carotid artery towards the ipsilateral nipple. Venipuncture occurs within 2 to 4 cm while the needle is slowly withdrawn. If the initial thrust is unsuccessful the next attempt should be at a 5 degree lateral angle, followed by a cautious attempt more medially, never crossing the plane of carotid artery.

3. Posterior approach[18,28,29,30]

This approach uses the EJV as a surface landmark. The needle is introduced 1cm dorsally to the point where the EJV crosses the posterior border of sternocleidomastoid muscle or 5cm cephalad from the clavicle along the clavicular head of sternocleidomastoid muscle. The needle is directed caudally and ventrally towards the suprasternal notch at an angle 45 degrees to the sagittal plane, with 15 degree upward angulations.

Venipuncture occurs within 5 to 7cm. If this attempt is unsuccessful, the needle should be aimed slightly more cephalad on the next attempt

Success Rate

IJV catheterization is associated with a high rate of successful catheter placement regardless of the approach used. Elective procedures are successful more than 90% of the time generally within the first three attempts and catheter malposition is rare[15,18,19,20,22,25,26,31]. Emergency IJV cannulation is less successful than elective procedure .

Complications

The incidence and types of complications are similar regardless of the approach. Operater's inexperience appears to increase the number of complication but to an undefined extent and probably does not have as great an impact as it does on incidence of pneumothorax in subclavian venipuncture The overall incidence of complications in IJV catheterization is 0.1% to 4.2%[18,28,33,35]. Important complication include ICA puncture, pneumothorax, vessel erosion, thrombosis and infection by far the most common complication is ICA puncture which constitute 50% to 90% of all complications. In the absence of a bleeding diathesis arterial puncture are benign and are managed conservatively without sequelae by applying local pressure for 10 minutes. Even in the absence

of clotting abnormalities, a sizable hematoma may form frequently preventing further catheterization attempt or rarely exerting pressure on vital structures[36,37]. Unrecognized arterial puncture can lead to catheterization of the ICA with a large bore catheter or introducer and can have disastrous consequences, especially when heparin is administered[38]. Chronic complications, which result from ICA puncture, include hematoma requiring surgical excision, arterio venous fistula and pseudo aneurysm. Pneumothorax has an average incidence of 0% to 0.2%[22,29,33,35]. It usually results from a skin puncture too close to the clavicle. Pneumothorax can be complicated by heme infusion or tension[17].

Other complications include hemothorax, hemomediastinum, arterial thomboembolism, subcutaneous / mediastinal emphysema, chylothorax, endotracheal tube cuff puncture, catheter tip malposition and catheter related sepsis.

REVIEW OF LITERATURE

Sulek et al 2000[39]

They conducted a prospective randomized controlled trial (level 36) in 120 patients posted for elective abdominal, vascular or cardiothoracic surgery. The patients were randomized into 4 groups (30 patients each) Group 1 – Right IJV landmark technique, Group 2 – Right IJV 2-D ultrasound technique, Group 3 – Left IJV landmark technique, Group 4 – Left IJV 2-D ultra sound technique. The results expressed as right IJV landmark technique Vs Left IJV landmark technique are as: The time taken for guide wire insertion was 137+/- 13.9 vs 247 +/- 17.6 sec (Right IJV <Left IJV). The number of attempts for guide wire insertion was 2.1 +/- 0.9 vs 3.5 +/- 1.3 (Right IJV <Left IJV) The incidence of failed guide wire placement was 3.3% 13.3% (Right IJV < Left IJV). The incidence of complications (combined artery puncture and hematoma) was 18/120 (15% overall complication rate), 13.3% vs 26.7% (Right IJV< Left IJV). They concluded that left IJV is more time consuming than right IJV cannulation and is associated with higher incidence of complications.

Andrews et al 2000[40]

They conducted a study in 100 patients and measured the distance from skin puncture site atriocaval junction in central venous cannulation by various routes. These distances were: right internal jugular vein to atriocaval junction was 16.0 +/- 2.0cms, left internal jugular vein to atriocaval junction was 19.1+/-1.9 cms, right subclavian vein to atriocaval junction 18.4+/-2.8 cms, and left subclavian vein to atriocaval junction was 21.2+/-1.6 cms.

Mc Gee WT et al 1996[41]

They conducted a prospective study in 127 patients who required central venous cannulation via either the internal jugular vein or the subclavian vein. They used 16 cm (n-102) or 20 cm (n-25) central venous catheters and assessed the relationship of right or left sided internal jugular or subclavian vein insertions intracardiac catheter placement. Use of a 20 cm CVC resulted in 14 of 25 (56%) intracardiac placements compared with 11 of 102 (11%) used a 16 cm catheter ($P< 0.0001$).

All intracardiac placements with 16 cm CVC were from right sided approaches: IJV 7 of 38 (16%) subclavian 4 of 18 (18%) use of a 16 cm CVC to access central circulation from either the SCV or the IJV results

in a significantly greater proportion of safe catheter placement than using longer CVCs and it should become the standard care.

Peres PW et al 1990[42]

They conducted a prospective survey of 266 central venous catheterizations by various routes evaluating their success rate and incidence of immediate complications and attempts to demonstrate a relationship between patient height and ideal catheter length. The overall rate of intrathoracic placement was 230 from 239 catheterisations (96%). Of these 230 catheters, 54 terminated in right atrium (24%). To avoid right atrial placement with its well documented risk of cardiac tamponade, it was recommended that right infraclavicular subclavian catheters are inserted to height/10 – 2 cm, right internal or external jugular catheter to height/10 cm and left internal or external jugular catheters to height/10 +4 cm.

Schwarzmann et al 1987[43]

They submitted a case report revealing an unusual faulty placement of left internal jugular catheter. A catheter had been placed by the seldinger technique, into the left internal jugular vein of a 29 year old man requiring intensive care. Routine radiological check of its position using contrast medium (conray) revealed its tip to be in the pericardial

vein. They suggested the reason for malposition was due to the course of venous system in the region of the left brachoicephalic vein.

Muhm M et al 1997[44]

Their study was undertaken to determine the incidence of aberrant locations dependent on different anatomic approaches for various types of central venous catheters and to elucidate failure and pitfalls of preventive practices. The study included 2580 percutaneously inserted central venous lines introduced by seldingers technique & were reviewed for inadvertant positioning. Primary misplacement was evident on 47 occasions (1.82%), 38 times into large venous tributaries of SVC. 3 aberrant locations involved a persistent left superior vena cava, two catheters were placed into minor intrathoracic veins and in 3 patients inadvertant arterial cannulation occurred. The frequency of malpositioning was related to the anatomic approach and the catheter type used, but not to the physician's experience. Respective indices were 4.12% for left internal jugular access, but were lower for the right internal jugular (1.1%) and the right (1.01%) and left (0.89%) supraclavicular approach. All malpositions but one was detected on chest X-Ray.

Stephen S. Kwon et al 2002[45]

They reported a case of thoracic duct injury with left internal jugular venous cannulation. Left sided internal jugular venous catheter

was required for a 49 year old man for hemodialysis as he recently had an arteriovenous fistula in his right upper extremity immature. Vessel wall puncture was made in the left IJV with 21 gauge needle under USG guidance. Only one pass was required to cannulate the vein. The puncture site was sequentially dilated to allow placement of a 15 F peel away sheath. A subcutaneous tunnel was created along the left anterior chest and tunneled catheter was placed without difficulty in the standard fashion. 10 minutes after the procedure, dressing was soaked with non blood fluid. When dressing was removed, a persistant leak of opalescent fluid from the venotomy site was observed. The catheter was injected with optiray 30 under fluoroscopy and no extravasation of contrast material through the catheter or around the venotomy site was seen, so the catheter was left in place. A thoracic duct injury was suspected. Lab analysis of fluid revealed a triglyceride level of 147 mg / dl /confirming its chyle nature CT chest was done to revaluate chylothorax and was unremarkable.

Aminul Haq et al 1981[46]

They gave a case report in which central venous catheter was introduced percutaneousy into the left internal jugular vein. The catheter advanced easily and when it was in its final position, blood was readily aspirated. No discomfort was noted by the patient either during the

procedure or immediately thereafter. Several minutes following start of infusion of cephalothin, patient complained of severe left shoulder and left pleuritic pain, the pain subsided soon after the infusion was stopped. Chest x ray revealed aberrant position of central venous catheter. No pneumothorax was noted. An injection of renografin-76 through the catheter confirmed its location in the left internal thoracic vein.

R.E.Sheep et al 1982[47]

They reported a case of fatal cardiac tamponade caused by superior vena cava perforation and two cases of nonfatal hydro mediastinum and hydrothorax as a result of left internal jugular venous catheterization.

M.P.Prim et al 2002[48]

They conducted a study to assess the possible differences between right and left internal jugular vein in Head and neck cancer patients, in order to choose one of them for cannulation. It was a prospective study including 102 internal jugular veins of 51 Head and neck cancer patients evaluated by means of Duplex Doppler ultrasonography. Patency, characteristics of vein wall , compressibility area of vein both at rest and during valsalva maneuver expiratory flow speed , Valsalva flow speed, and jugular flow on each side were registered in all veins. All Parameters were higher on right side but area during Valsalva (P=0.047) and jugular

flow (p=0.047) showed a significant difference. They concluded that the area parameters of the right internal jugular vein suggest more favorable anatomical conditions for placement of central venous catheters than the left one.

Lobato EB et al 1999[49]

They conducted a study in 50 healthy adult volunteers to assess the cross sectional area of right and left internal jugular vein with the help of a 5 MHz, 2D surface transducer before and during 10sec Valsalva in supine position and then with the subject in a 10 degree trendlenberg tilt. 80% of the volunteers had left internal jugular vein cross sectional area smaller then right in which n=7 (34%) had cross sectional area less than 50% of that of the right IJV they concluded that in one third of adult (34%) the left IJV was significantly smaller compared with right IJV and hence right IJV may have higher success rate and fewer complication compared to left IJV.

Ulku C.Turba et al 2005[50]

They conducted a study with one hundred and eighty eight patients to demonstrate the anatomic relationship of internal jugular vein with the common carotid artery. The position of IJV in relation to CCA was demonstrated by portable ultrasonography. IJV location was recorded in a

clock dial systems using the carotid as the center of the dial and the angles were measured .The result were as IJV was lateral to CCA in 187 of 188 patients and medial to the CCA in one patient. The left IJV was at the 12’0 position in 12 patients (6%) , 11’0 clock position in 17 patients (75%), at 10’0 Clock position in 142 patients (75%) and at 9’0 clock position in 17 patients (9%). The right IJV was at 12’0 clock position in 8 patients (4%), 1’0 clock position in 31 patients (6%), 2’0 clock position in 134 patients (7%) and 3’0 clock position in 17 patients (9%) . They concluded that the area parameters of the right internal jugular vein suggest more favorable anatomical condition for placement of central venous catheters than the left one.

MATERIALS AND METHODS

Study Design

This study was conducted in cardio thoracic operation theatre at the Government General Hospital, Chennai between May 2007 and August 2007 on forty patients posted for elective major cardiac surgery. This study was done after institutional approval and written informed constant was obtained from all the patients included in this study.

This study was done in a prospective randomized manner. Forty patients of either sex posted for major elective cardiac surgeries satisfying the selection criteria were randomly allocated into the two groups (Group R and Group L).

Group R: Patients in this group underwent right sided internal jugular venous cannulation by central approach of traditional blind anatomic landmark technique.

Group L: patients in this group underwent left sided internal jugular venous cannulation by central approach of traditional blind anatomic landmark technique.

Materials Used:

The triple lumen central venous catheter (20 cm – Length) manufactured by Arrow company were used for cannulation on both right and left side by anatomic landmark technique.

Selection of cases:

Inclusion criteria:

1. Age – 15 to 60 Years
2. Elective IJV cannulation

Exclusion Criteria:

1. Emergency cannulation
2. Coagulopathy
3. Neck deformities
4. Local sepsis
5. H/O i.v drug abuse
6. H/O IJV thrombosis

Preanaesthetic Evaluation:

Patients included in this study underwent thorough preoperative evaluation which included history, detailed physical examination and investigation.

Patients who satisfied the inclusion criteria were explained about the nature of the study and the anesthetic procedure. Written informed constant was obtained from all the patients included in the study.

Two persons were required during the study. One was the operator (myself) who did the cannulations. Second was the observer who was recording the parameters. All the parameters and events were observed and recorded in the proforma by the observer throughout the procedure.

Training / Pilot study:

The operator (myself) did a pilot study on 10 patients, who were selected based on above mentioned criteria, under expert guidance and supervision of senior anesthesiologists. Left internal jugular venous cannulation was done in 5 patients and Right IJV cannulation in 5 patients. After the pilot study, the observation and results were analysed in detail and based on the safety profile the institutional approval was obtained for conducting the present study.

Preparation:

Standard monitoring for cardiac patients was done. Intravenous access with two 16G venflons were achieved. Premedication with midazolam 0.05 mg/kg and inj.morphine 0.1 mg /kg was given.

Oxygenation with face mask 6 lit/min given. Patients positioned in 15 degree trendlenburg position with a small bed roll between shoulder blades, head turned slightly to the contralateral side, arms kept to the side of the body. Technique was done under strict aseptic precaution with LA infiltration.

Technique:

Group R: The classic central approach for IJV cannulation was done. The operator stood at the head end of the patient. The anatomic landmarks were defined by palpating the two heads of sternomastoid muscle and locating the apex of the triangle formed by them. The carotid artery pulsation was felt 1 to 2 cm medial to this point, beneath or just medial to the sternal head of sternomastoid muscle. A 22 G 1½ inch finder needle mounted on a 5 ml heparin saline loaded syringe was first used to locate the IJV. The operator maintained slight or no pressure on the carotid artery with the left hand and inserted the finder needle with the right hand at the apex of the triangle at a 30 to 45 degree angle with the frontal plane, directed at the right nipple. The needle was advanced steadily with constant back pressure and venipuncture occurred within 3 to 5 cm . When venipuncture occurred with the finder needle demonstrated by the free aspiration of dark venous blood, the operator made a note of the direction and depth of the needle before withdrawing

the finder needle. The 18G thin wall needle mounted on a 5ml heparin saline loaded syringe was introduced in the identical plane and venipuncture was attempted in the same direction and depth. Once venipuncture occurred, free aspiration of dark venous blood was demonstrated. The syringe was removed during expiration or valsalva maneuvre and the hub occluded with a finger after ensuring that the back flow is not pulsatile. The operator secured the needle in place with one hand removing the syringe with the other. The needle was stabilized to prevent migration prior to guidewire insertion. The J tip of the guide wire was then inserted freely upto 20 cm at which point the 18G needle was withdrawn.With the guidewire in place , a scalpel was used to make a 90 degree stab incision at the skin entry site to facilitate passage of the vessel dilator. The dilator was inserted down the guide wire to the hub, ensuring that control and sterility of the guide wire was not compromised. The dilator was then withdrawn and gauze was used at the puncture site to control oozing and prevent air embolism down the needle tract. The triple lumen catheter was then inserted over the guidewire ensuring that the guidewire protruded from the distal lumen hub before the catheter tip penetrated the skin. The catheter was then advanced 15 to 17 cm into the vein, the guidewire was withdrawn, and the distal lumen capped. The catheter was sutured to limit tip migration. The vertical distance from the level of cricoid cartilage to the skin puncture site was measured.

It venipuncture did not occur at the initial thrust, back pressure was maintained and the needle slowly withdrawn. If the first attempt was unsuccessful, the operator should reassess patient position, landmarks and techniques. Subsequent attempt was directed slightly laterally or medially to the initial thrust after reassessment of carotid artery position. If venipuncture did not occur with 18 G needle after insertion upto a depth 0.5 cm more than that of a successful finder needle insertion in the same direction or inability to locate the IJV with 18 G needle for more than 30 sec, the attempt was considered a missed attempt. The 18 G needle was withdrawn to skin and a fresh attempt was done. If the guidewire did not pass easily beyond the tip of 18G needle nor more than 10 cm,guide wire was withdrawn, the syringe was attached, and free backflow of blood was reestablihed. If this was not possible, the 18 G needle was withdrawn and a new attempt was done. If venipuncture was unsuccessful or cannulation was unsuccessful after 3 consecutive attempts with 18 G needle or if the operator was unable to cannulate for more than 30 minutes or the development of significant hematoma (>2 cm in any dimension) due to artery puncture, it was defined as failure. Failure was followed by an attempt to cannulate on the side (right) by posterior approach if there was no significant hematoma following arterial puncture or left IJV in case of significant hematoma by central landmark approach.

During surgery, once the pericardium was opened, the catheter tip position was assessed by the surgeon. If the catheter tip was beyond the atriocaval junction, the catheter was withdrawn till the tip was exactly kept at the junction. If the catheter tip was not at the junction nor beyond it, the catheter was pushed further to the point till the catheter tip was exactly kept at the junction. If the tip was exactly at the atriocaval junction no alterations were made. The length of catheter from the skin puncture site was now measured.

Group L:

The same classic central approach as mentioned above for group R was done for left IJV cannulation.

Failure was followed by an attempt to cannulate on the same side (left IJV) by posterior approach if there was no significant hematoma following arterial puncture or right IJV in case of significant hematoma by central landmark approach.

All other parameters observed and the interpretations done in case of any problem were similar as that in group R.

Parameters observed:-

1. The time taken with the pilot needle to locate the IJV.
2. The time taken with the 18 G needle to locate the IJV.
3. The number of attempts required with the 18 G needle to successfully cannulate the IJV.
4. The number of attempts required for successful guide wire insertion.
5. Failure to cannulate the IJV.
6. Total access time.
7. Acute complications observed.

(i) Carotid artery puncture.

(ii) Hematoma

(iii) Other (if any)

8. Depth of cannulation.

1. The time taken with the pilot needle to locate the IJV (in sec)

The time was noted from the point of skin contact of pilot needle till free aspiration of dark venous blood. The time taken to define the anatomical landmarks was not included.

2. The time taken with the 18 G needle to locate IJV (sec)

The time was noted from the point of skin contact of the 18 G needle till the free aspiration of dark venous blood confirming the location of IJV.

3. The number of attempts required with the 18 G needle to Successfully cannulate the IJV

The total number of attempts required to successfully cannulate the IJV including the missed attempts were recorded. Missed attempt: Defined as an attempt in which the venipuncture did not occur with the 18 G needle after insertion upto a depth 0.5 cm more than that of a successful finder needle for more than 30 sec.

4. The number of attempts for successful guide wire insertion

The number of attempts required for successful guide wire insertion more than 10 cm freely through the 18 G needle was noted.

5. Failure to cannulate the IJV

Failure was defined as procedure during which cannulation was unsuccessful after 3 consecutive attempts with the 18 G needle or if more than 3 attempts were required for guide wire if the operator was unable to cannulate for more than 30 minutes or the development of significant

hematoma (> 2 cm in any dimension) due to artery puncture. Failure was followed by methods as mentioned above in the technique.

6. Total access time (in sec)

The total time taken to successfully cannulate the IJV was recorded from the point of skin contact of the 18 G needle till the successful insertion of triple lumen catheter was confirmed by the free aspiration of dark venous blood.

7. Acute complications observed

a) Artery puncture: Carotid artery puncture during the procedure was documented. The artery puncture was followed by compression for 3 minutes to avoid hematoma formation.

b) Hematoma: The development of significant hematoma (> 2 cm in any dimension) was documented.

c) Other complications: The other complications looked for were hemothorax, hemomediastinum, arterial thromboembolism, pneumothorax, subcutaneous / mediastinal emphysema, endotracheal tube cuff puncture which were common for both groups. Thoracic duct injury was looked for in group L. Catheter malpositions were looked for if the catheter tip was not able to be

brought to the atriocaval junction. Post operative chest X-Ray was taken to confirm the exact site.

8. Depth of cannulation (in cm)

The vertical distance from the cricoid level to the skin puncture site and the length of catheter from the skin puncture site to the atriocaval junction are measured. The sum of these two gives the depth of cannulation.

OBSERVATIONS AND RESULTS

Forty patients of either sex posted for major elective cardiac surgeries satisfying the selection criteria were randomly allocated into two groups. (Group R, Group L – 20 patients each)

Group R: Patients in this group underwent right sided internal jugular venous cannulation by central approach of traditional blind anatomic landmark technique.

Group L: Patients in this group underwent left sided internal jugular venous cannulation by central approach of traditional blind anatomic landmark technique.

Table 1(a): Demographic Profile:

Parameter	Group	n	Mean	SD	Students 't' test
Age	L	20	30.65	14.438	p=0.675
	R	20	28.90	11.625	
Height	L	20	158.15	8.475	P=0.446
	R	20	160.1	7.525	
Weight	L	20	53.2	9.512	p=0.778
	R	20	52.45	6.985	

Table 1(b) Sex Profile:

Group	**Sex**		**p Value**
	Male	Female	
L	15 (75%)	5 (25%)	p= 0.320
R	11 (55%)	9 (45%)	

The two groups were similar with respect to age, height, weight & sex

Table 2: Time taken with pilot needle to locate IJV:

Group	n	Mean	SD	P Value
L	20	9.75(sec)	2.124	p=0.517
R	20	9.40(sec)	1.095	

Group R required (9.40 +/- 1.095 sec) to locate IJV when compared to group L (9.75 +/- 2.124 sec) which was statistically not significant.

Table 3: Time taken with the 18 G needle to locate IJV

Group	N	Mean	SD	P Value
L	20	11.55(sec)	2.064	0.007
R	20	10.1 (sec)	0.968	

Group R required considerable less time (10.1 +/- 0.968 sec) located the IJV with 18 G needle when compared to group L (11.55 +/- 2.064 sec) this was found to be statistically significant.

Table 4: The number of attempts required with 18 G needle to successfully cannulate IJV:

Group	No of patient cannulated at			
	1st attempt	2nd attempt	3rd attempt	4th attempt
L	5 (25%)	11 (55%)	3 (15%)	1 (5%)
R	14 (70%)	4 (20%)	2 (10%)	0

p= 0.033

In group R, 14 patients were cannulated at first attempt, 4 patients required 2 attempts, 2 patients required 3 attempts. In Group L, only 5 patients were cannulated at first attempt, 11 patients required 2 attempts, 3 patients required 3 attempts and 1 patient required 4 attempts (which was a case of failure to cannulate). The difference was statistically significant.

Success rate at first attempt:

Group R = 14/20 = 70%

Group L = 5/20 = 25%

Group R had 70% success rate at first attempt, whereas in Group L, success rate at first attempt was only 35% and this difference was found to be statistically significant.

Table 5: No of attempts for successful guide wire insertion:

Group	No of patients with successful guide wire insertion at		
	1st attempt	2nd attempt	3rd attempt
L	12 (60%)	6 (30%)	2 (10%)
R	20 (100%)	0	0

p=0.007

In group R, guide wire insertion was successful at first attempt in all the 20 patients. In group L, guide wire insertion was successful at first attempt only in 12 patients, 6 patients required 2 attempts, 2 patients required 3 attempts.

The difference was found to be statistically significant.

Table 6: Total access time (in sec)

Group	n	mean (sec)	SD	P Value
L	20	334.85	93.514	0.038
R	20	282.35	56.784	

Group R required less time for central venous access (282.35 +/- 56.784 sec) when compared to Group L (334.85 +/- 93.514 sec). The difference in the total access time of the two groups was statistically significant.

Table 7: Failure to cannulate the IJV:

Group L = 4/20 (20%)

Group R = 0/20 (0%)

p=0.07

Group L had a failure rate of 20% when compared to Group R 0%. The difference was statistically not significant.

Table 8: (a) Acute complications observed

Group L = 4/20 (20%)

Group R = 0/20 (0%)

P=0.07

Carotid artery puncture rate was 20% (4/20) in Group L compared to 0% (0/20) in Group R. This complication was statistically not significant.

(b) Hematoma rate:

Group L = 4/20 (20%)

Group R = 0/20 (0%)

p=0.07

All the arterial punctures were followed by hematoma formation. So the incidence of hematoma was same as that of carotid artery puncture.

Table 9: Depth of cannulation

Group	n	Mean	SD
L	20	17.33	1.582
R	20	14.89	0.880

p=0.000

The depth of cannulation in Group R was (14.89 +/- 0.880 cm) compared to (17.33 +/- 1.582 cm) in Group L. It was found to be statistically significant.

STATISTICAL ANALYSIS

Mean and standard deviation were estimated for the various parameters in each group. The mean values were compared by student's independent't' test.

Proportion and variables from each study group were compared by Pearson's chi square test. In this study 'p' value < 0.05 was considered as level of significance.

DISCUSSION

The observations and results show a clear benefit from right sided internal jugular venous cannulation compared with left sided internal jugular venous cannulation. This is manifested as a lower failure rate, high success rate, a reduction in complications, and faster access. These findings are similar to the results of previously published studies and metanalysis of randomized controlled studies comparing these two techniques.

Demographic Profile:

The major prospective controlled trials comparing the right and left sided internal jugular venous cannulation which were conducted in cardio thoracic patients: Sulek et al[39], 2000 USA, Andrews et al[40], 2000, Portland and Lobato EB et al[49] 1999 were included.

The present study included the patients posted for major elective cardiac surgeries like coronary artery bypass grafting, valve replacement surgeries (mitral / aortic / both), repair of atrial septal defect. This clinical setting was chosen based on the results during the periods of hands on training under the expert guidance. Further more, this controlled environment of cardiothoracic operation theatre provided sufficient

facilities and safety features for conduct of the study. In the present study, both the two groups were similar with respect to age, height, weight and sex.

The time taken with the pilot needle to locate the IJV (in sec)

The institutional protocol insists on the use of a pilot needle for the landmark technique and hence this parameter was observed and analyzed.

The time from the point of skin contact of the pilot needle till free aspiration of dark venous blood. The time taken to define the anatomical landmarks was not included.

In the present study the right sided group required 9.40 +/- 1.095 sec to located IJV with pilot needle when compared to the left sided group which required 9.75 +/- 2.124 sec, which was statistically not significant (p=0.51).

The time taken with 18 G needle to locate the IJV

The time was noted from the point of skin contact of the 18 G needle till the free aspiration of dark venous blood which confirmed the location of IJV during the final attempt that resulted in successful cannulation.

In the present study, the right sided group required less time (10.1 +/- 0.968 sec) to locate the IJV with the 18 G needle when compared to the left sided group (11.55 +/- 2.064 sec) and this was found to be statistically significant (p=0.007) Though the difference was very small, it was probably attributed to the cross sectional area parameter difference between the right and left IJV.

Number of attempts for successful guide wire insertion:-

The number of attempts required for successful guide wire insertion more than 10 cm freely through the 18 G needle was noted.

Sulek et al[39]:

In this trial, the number of attempts for guide wire insertion was 2.1 +/- 0.9 for right IJV and 3.5 +/- 1.3 for left IJV.

In the present study, it was found in left sided group that only 12 patients were been able to have guide wire insertion at first attempt, 6 required 2 attempts, 2 required 3 attempts. In contrast, in the right sided group, guide wire insertion was successful at first attempt in all 20 patients. The mean number of attempts required in the left sided group was 1.5 +/- 0.688 while the right sided group required only one attempt in

all cases. The difference was statistically significant. The result was in concurrence with the above study.

Total access time:-

The total time taken to successfully cannulate the IJV was recorded from the point of skin contact of 18 G needle till the successful insertion of triple lumen catheter was confirmed by free aspiration of dark venous blood.

Sulek et al[39]:

In this study there was significant reduction in the time taken for guide wire insertion in right sided group (137 +/- 13.9 sec) when compared to the left sided group (247 +/- 17.6 sec).

In the present study also the total access time which includes the time required for guide wire insertion, was less (282.35 +/- 56.784 sec) for right sided group when compared to the left sided group (334.85 +/- 93.514 sec) .There was considerable delay due to various factors like inadvertent artery puncture, compression of artery puncture, hematoma obscuring the anatomy, missed attempts, difficulty in cannulation, failure of cannulation. The difference in the total access time of the two groups was found to be statistically significant.

Depth of cannulation:

The vertical distance from the cricoid level to the skin puncture site and the length of catheter from skin puncture site to the atriocaval junction are noted. The sum of these two was the depth cannulation.

Andrews et al[40]:

In their study, the mean distance from the common skin puncture site to the atriocaval junction was 16 +/- 2.0 cm for right IJV approach and it was 19.1 +/- 1.9 cm for left IJV approach.

In the present study also it was nearly similar. It was 14.89 +/- 0.880 cm for right IJV and as 17.33 +/- 1.582 cm for left IJV. The study was statistically significant (p = 0.000).

This was probably due to the longer course of left IJV compared to the right.

Success rate at first attempt:

Lobato EB et al[49]:

Their study compared the success rate of right and left IJV cannulation by assessing the cross sectional area of right and left IJV. 80% had left internal jugular vein cross sectional area smaller than right internal jugular vein in which 34% had cross sectional area less than 50%

of that of the right IJV and concluded that right IJV had higher success rate than left.

In the present study, the number of attempts with the 18 G needle to cannulate the IJV was calculated. In left sided group only 5 patients were cannulated at first attempt, 11 patients required two attempts, 3 patients required three attempts and 1 patient required 4 attempt (which was a case of failure to cannulate). In contrast, in right sided group, 14 patients were cannulated at first attempt, 4 patients required two attempts and 2 patients required three attempts. The number of attempts included missed attempts, attempts in which inadvertent artery puncture occurred and attempts in which IJV was hit but cannulation could not be done because of needle tip displacement. The difference was found to be statistically significant (p=0.033). With this, the success rate at first attempt for right sided group was 70% and it was only 25% for left sided group.

Failure rate:-

Failure was defined as procedure during which cannulation was unsuccessful after 3 consecutive attempts with 18G needle or if more than 3 attempts were required for successful guidewire insertion or if the operator was unable to cannulate for more than 30 minutes or the

development of significant henatoma(>2 cm in any dimension) due to artery puncture.

Sulek et al[39]:

In this study, the incidence of failed guidewire placement was 13.3% for left sided IJV and was only 3.3% for right sided IJV.

In this present study also the failure rate was in concurrence with the above study. The left sided group had a significant failure rate of 20% when compared to the right sided group 0%(p=0.07, not significant). Among the failure cases one case which required more than three attempts to cannulate was one among the 4 cases which developed significant hematoma.

Acute Complication observed:-

Complication was probably due to the existance of normal anatomic variation, increased number of attempts with the 18G needle & positioning errors.

Sulek et al[39]:

In their study, the incidence of combined artery puncture and hematoma was 13.3% on right side, and 26.7% on left side.

In the present study, carotid artery puncture occurred in 4 out of 20 cases studied (25%) in left sided group whereas there was none in the right sided group (0%). Hematoma followed in all 4 cases of carotid puncture even with adequate compression. Hence the incidence of hematoma was also the same as that of carotid puncture (p=0.07, not significant). 0% complication rate on the right sided group differs widely from the above study group. This can be attributed to the smaller study population included.

SUMMARY

In this study comparing the right sided and left sided internal jugular venous cannulation by the traditional blind anatomic landmark technique, the following parameters have been observed and statistically analyzed: the time taken with the pilot needle to locate the IJV, the time taken with 18 G needle to locate the IJV, the number of attempts for successful guidewire insertion, the total access time, depth of cannulation, the success rate, the failure rate and the complication rate.

1. The mean time taken with the pilot needle to locate the IJV in,

   Group R – 9.40 +/- 1.095 sec

   Group L – 9.75 +/- 2.124 sec

   There is reduction in time taken to locate the IJV in group R.

2. The mean time taken with 18 G needle to locate the IJV in ,

   Group R – 10.1 +/- 0.968 sec

   Group C – 11.55 +/- 2.064 sec

   Significant reduction in time taken to locate the IJV with 18 G needle in Group R.

3. Mean number of attempts for successful guidewire insertion in

   Group R – 1.0

   Group L – 1.5 +/- 0.688

   Significant reduction in the number of attempts required for successful guide wire insertion in Group R.

4. The mean total access time in

   Group R – 282.35 +/- 56.784 sec

   Group L – 334.85 +/- 93.514 sec

   Significant reduction in the total access time in Group R.

5. The mean depth of cannulation in,

   Group R – 14.89 +/- 0.880 cm

   Group L – 17.33 +/- 1.582 cm

   The depth is significantly less for Group R.

6. Successful cannulation at first attempt in

   Group R – 14/20 – 70%

   Group L – 5/20 – 25%

   Significant reduction in the number of attempts required for successful cannulation in Group R.

7. Failure rate:

Group R – 0%

Group L – 20%

There was a reduction in failure rate in Group R.

8. Complication rate:

a) Carotid artery puncture rate

Group R – 0%

Group L – 25%

b) Hematoma rate:

Group R – 0%

Group L – 25%

There was a reduction in complication rate in Group R.

CONCLUSION

Right sided internal jugular venous cannulation is better compared to left sided internal jugular venous cannulation because the access time is less(time taken to locate with pilot needle, time taken to locate with 18G needle and total access time), insertion of guidewire at first attempt is excellent, depth of cannulation is less and failure rate is nil with no complications.

PROFORMA

COMPARISON OF RIGHT AND LEFT INTERNAL JUGULAR VENOUS CANNULATION BY THE TRADITIONAL BLIND ANATOMICAL LANDMARK TECHNIQUE

Date:

NAME OF THE PATIENT:

AGE; SEX: I P No:

DIAGNOSIS:

SURGICAL PROCEDURE PLANNED:

PRE ANAESTHETIC CHECK UP:

H/O Systemic illness-
H/O Previous IJV cannulation-
Other relevant history-
General examination:
Local examination of neck:
Height- Weight- BMI-
Vital signs: BP- PR- RR- SpO_2
CVS-
RS-
P/A-
CNS-
ASA status-
Airway assessment-

MODE OF ANAESTHESIA:

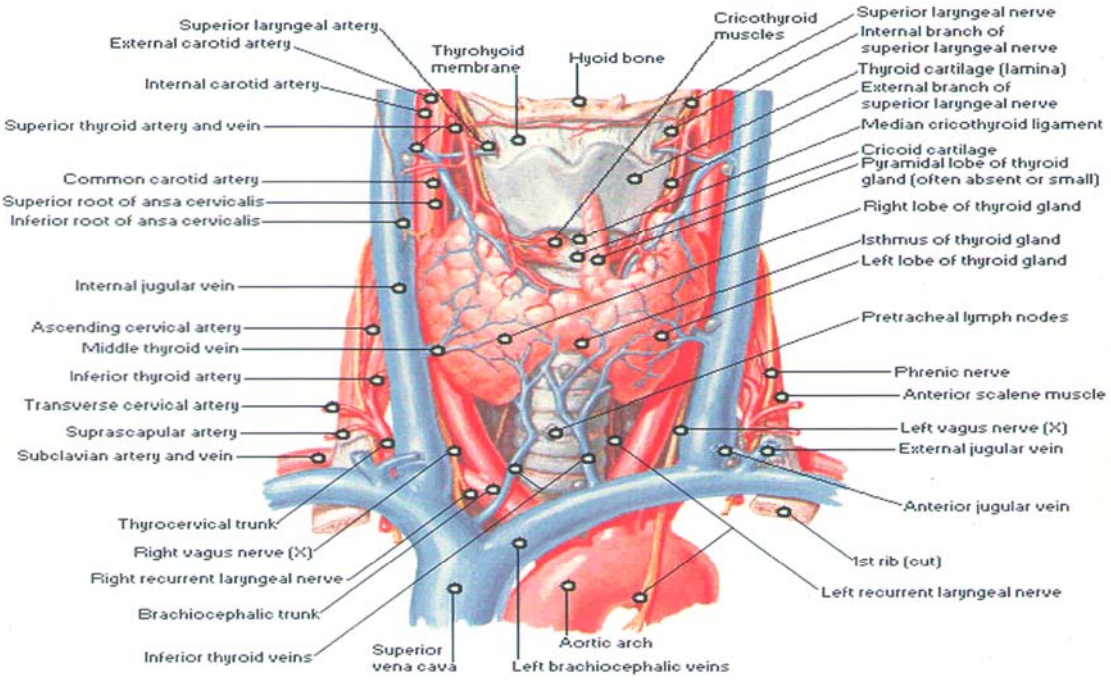
CENTRAL VENOUS CATHETER INSERTION:

Side of cannulation-

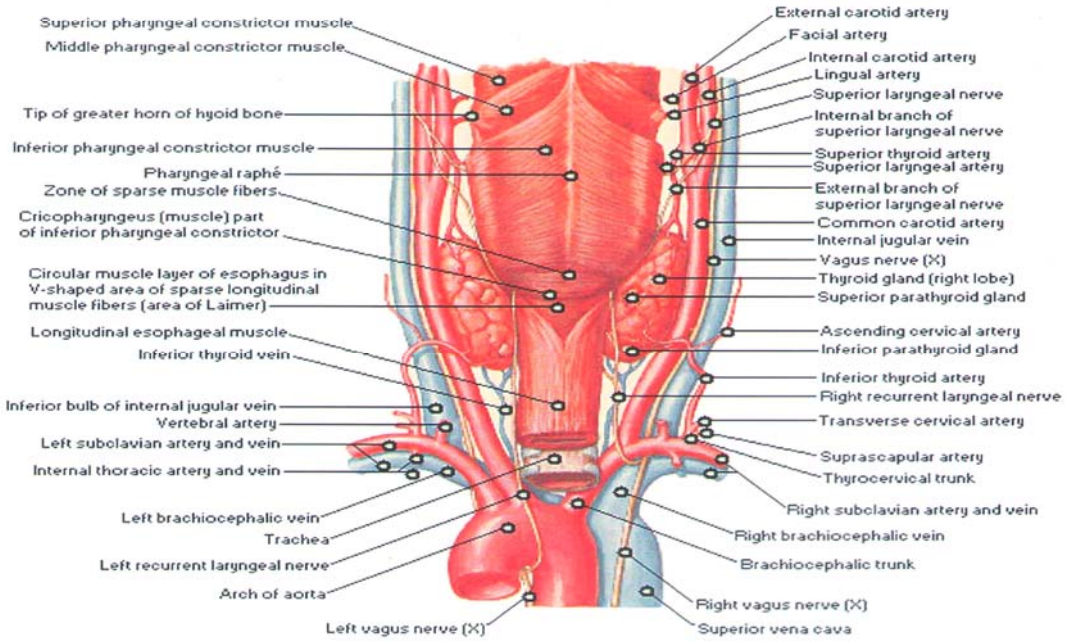
Parameters:

1. Time taken to locate IJV with pilot needle-
2. Time taken to locate IJV with 18 G needle-
3. No of attempts to locate IJV with 18 G needle-
4. No of attempts to successfully insert the guide wire-
5. Total Access Time-
6. Failure to locate at the first attempt-
7. Failure to insert guide wire at first attempt-
8. Failure to cannulate at first attempt-
9. Failure to cannulate -
10. Depth of cannulation-
11. Complications and their management-
12. Remarks-

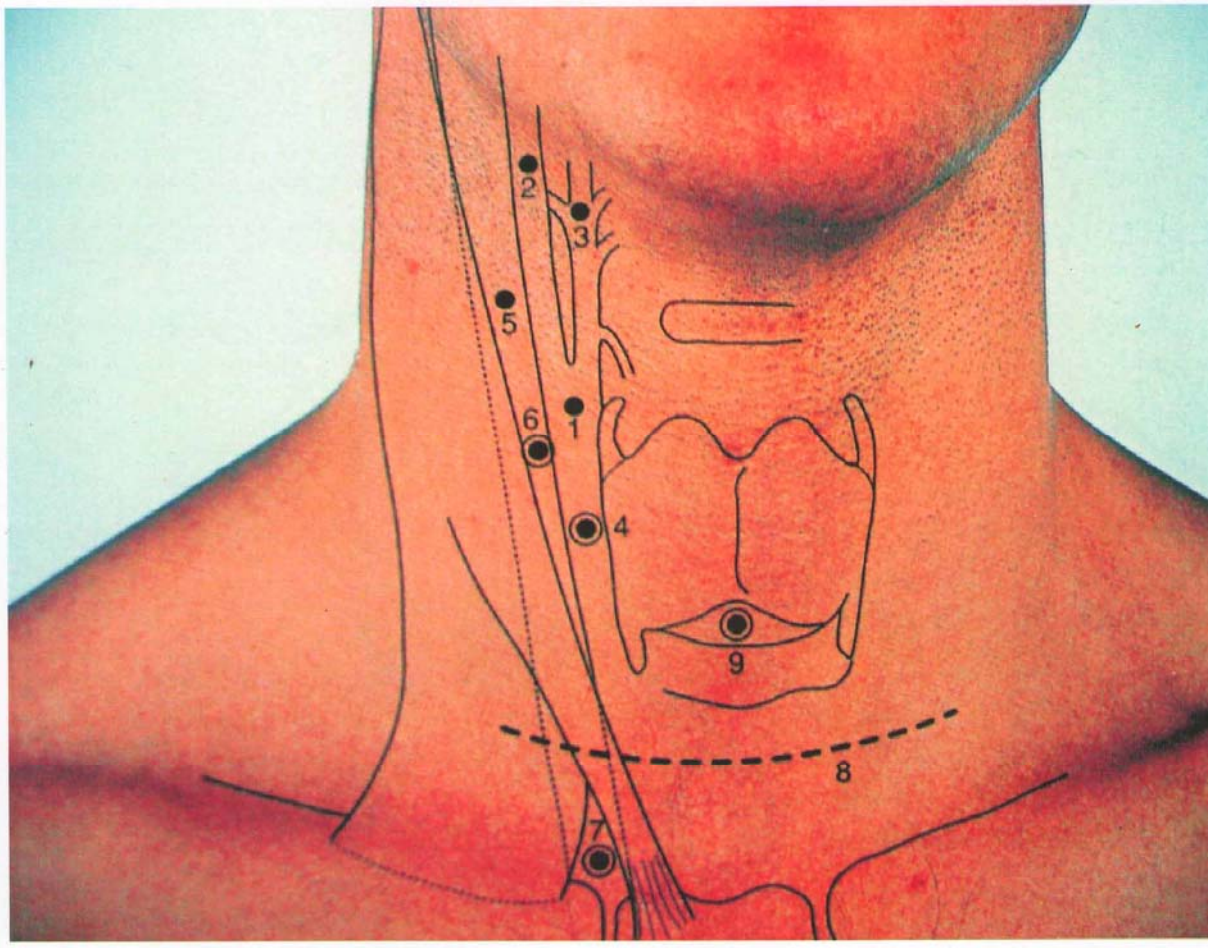
ANTERIOR RELATIONS OF IJV



POSTERIOR RELATIONS OF IJV

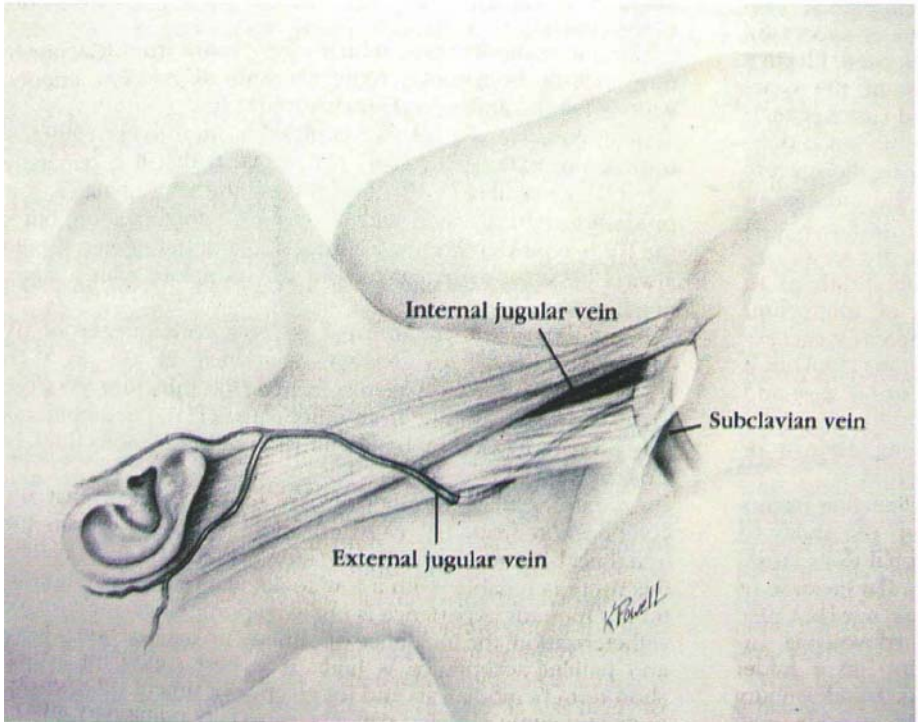


SURFACE LANDMARKS OF IJV

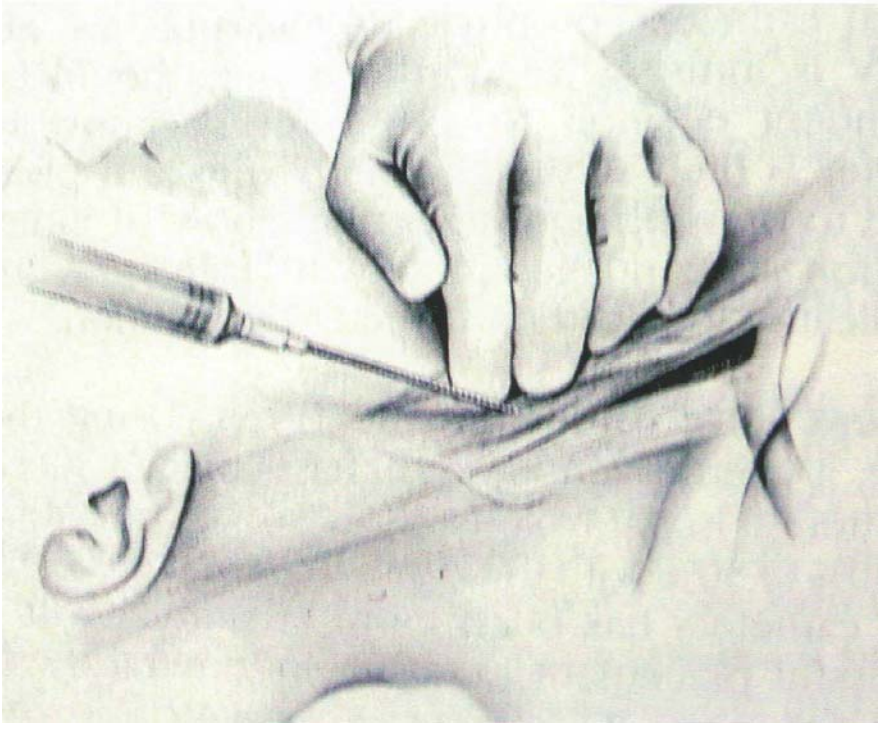


1. Division of common carotid artery
2. Internal carotid artery
3. External carotid artery
4. Common carotid artery
5. Internal jugular vein at hyoid level
6. Internal jugular vein at thyroid notch level
7. Triangular space formed by sternocleidomastoid muscle
8. Level of thyroid gland
9. Crico thyroid level

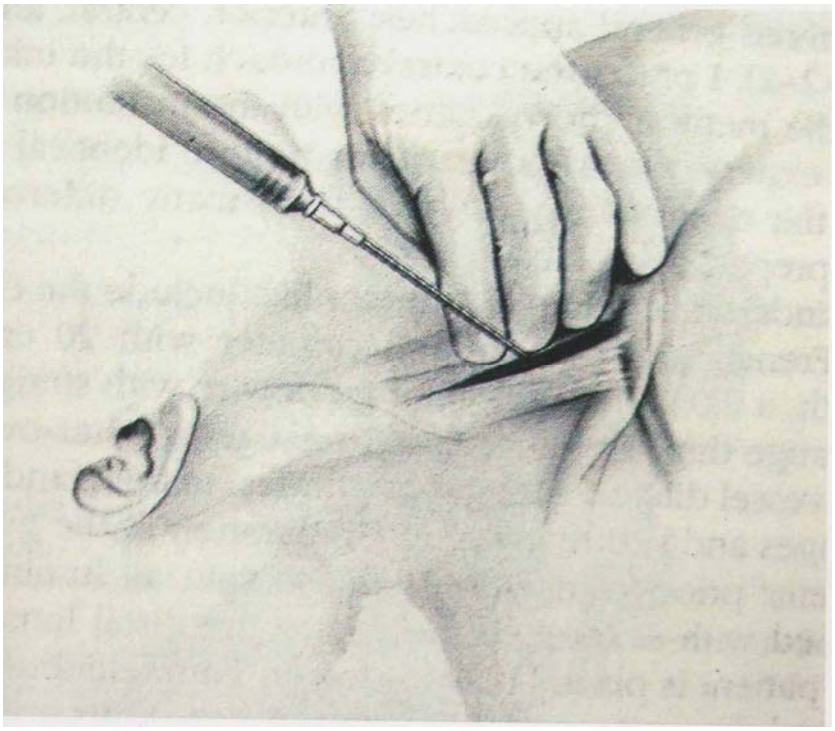
SURFACE ANATOMY OF IJV



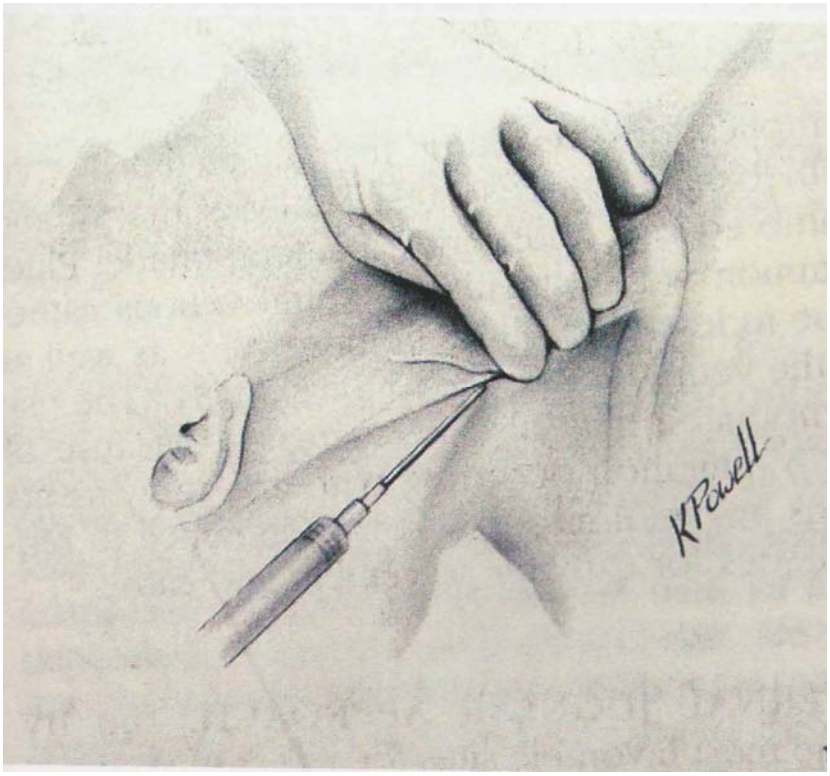
ANTERIOR APPROACH



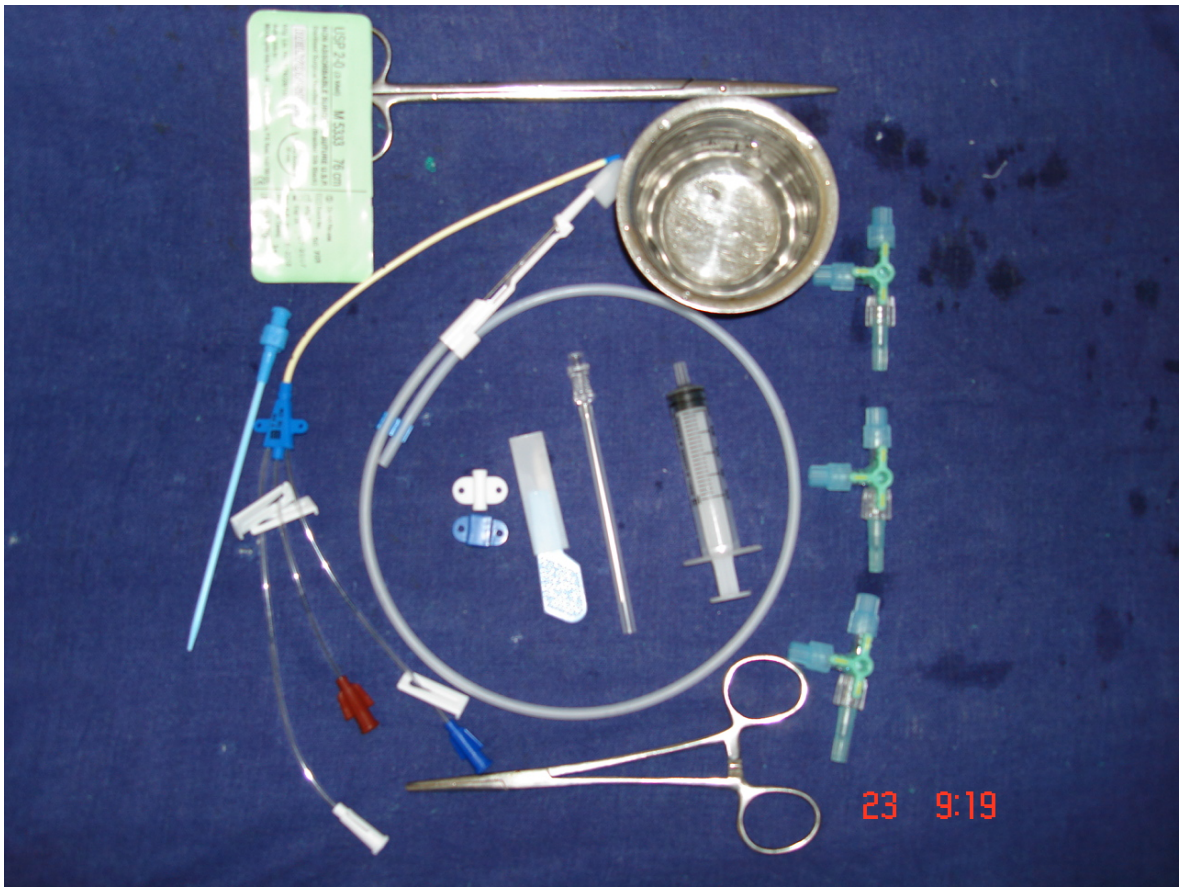
CENTRAL APPROACH



POSTERIOR APPROACH

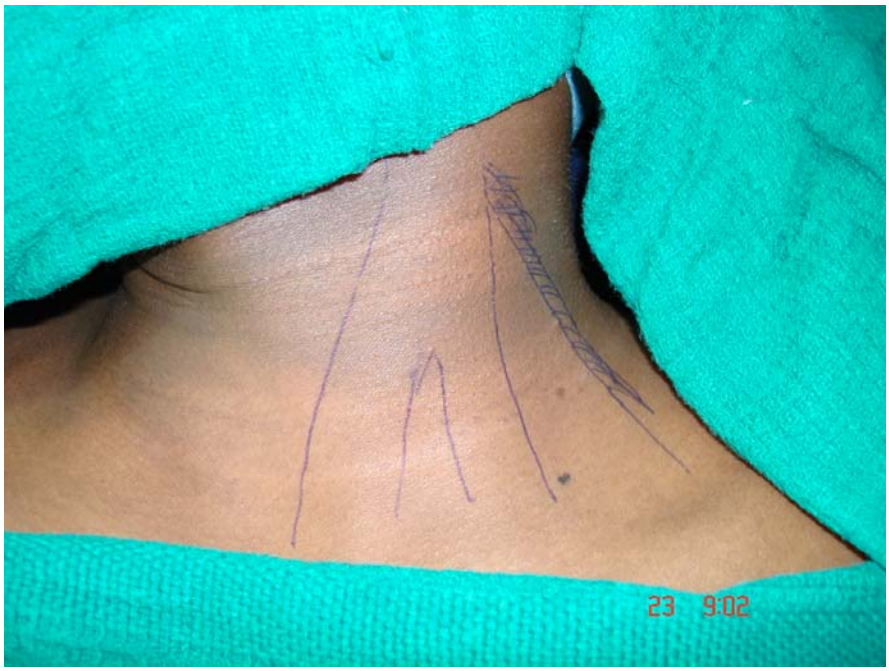


CANNULATION KIT



POSITION FOR RIGHT IJV CANNULATION

POSITION FOR LEFT IJV CANNULATION



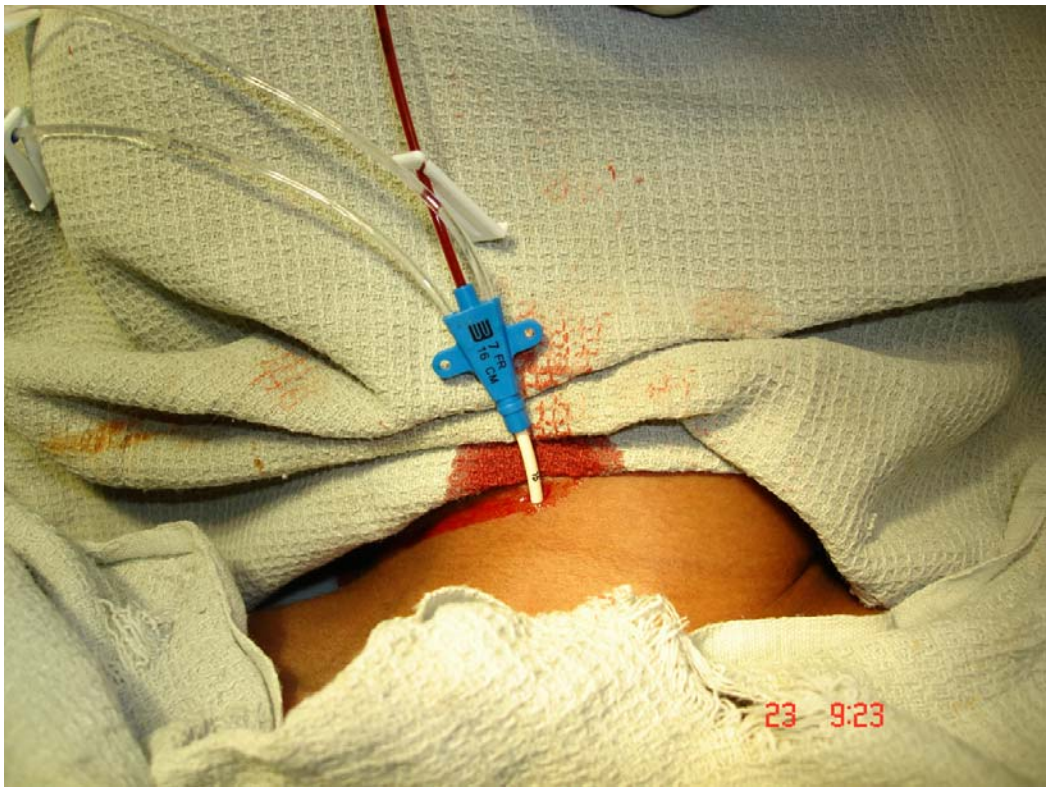
VENIPUNCTURE WITH PILOT NEEDLE

VENIPUNCTURE WITH 18 G NEEDLE

GUIDEWIRE INSERTION

DILATING THE TRACT

CENTRAL VENOUS CATHETER INSERTION



S. NO	I.P.NO	AGE	SEX	HEIGHT	WEIGHT	SIDE OF CANNULATION	MISSED ATTEMPTS	TOTAL ATTEMPTS 16G	GUIDE WIRE	TIME PILOT	TIME 18 G	TOTAL ACCESS TIME	FAILURE	CAROTID A INJ	HEMATOMA
1	27989	62	1	161	66	2	1	2	1	8	10	287		2	2
2	35860	36	1	162	67	2	1	2	1	10	12	**275**		2	2
3	37089	13	2	146	44	2	1	2	3	11	10	506		2	2
4	22810	41	2	142	46	2	0	1	2	7	10	278		2	2
5	29139	13	2	136	37	2	3	4	2	12	14	520	1	1	1
6	38852	26	1	168	66	2	1	2	1	9	15	268		2	2
7	42553	18	1	168	45	2	0	1	1	6	10	269		2	2
8	50299	29	2	161	51	2	1	2	3	13	12	514	1	1	1
9	44503	40	1	159	44	2	2	3	2	10	11	494		2	2
10	37212	29	1	160	52	2	1	2	1	12	15	269		2	2
11	37233	16	1	152	42	2	1	2	1	7	15	320		2	2
12	11752	29	1	166	54	2	0	1	2	10	10	278		2	2
13	27743	49	1	160	60	2	0	1	2	8	9	288		2	2
14	37314	20	2	154	46	2	2	3	1	12	11	366	1	1	1
15	29037	46	1	160	66	2	1	2	1	8	9	273		2	2
16	28500	45	1	162	60	2	1	2	1	11	12	314		2	2
17	27910	22	1	167	57	2	1	2	1	12	12	267		2	2
18	24592	48	1	160	65	2	1	2	2	10	11	283		2	2
19	43215	16	1	162	49	2	0	1	1	12	14	270		2	2
20	29608	15	1	157	47	2	2	3	1	7	9	358	1	1	1
21	40315	27	1	165	57	1	0	1	1	8	11	247		2	2
22	42598	15	2	146	39	1	0	1	1	9	9	256		2	2
23	22492	47	1	168	64	1	1	2	1	9	9	270		2	2
24	50267	40	2	150	48	1	0	1	1	10	9	250		2	2
25	48034	14	2	144	42	1	0	1	1	11	12	252		2	2
26	38907	25	2	155	48	1	0	1	1	10	11	246		2	2
27	45961	26	1	166	68	1	0	1	1	9	10	245		2	2
28	37203	27	1	169	52	1	1	2	1	10	10	366		2	2
29	37633	21	1	159	49	1	1	2	1	11	9	321		2	2
30	44725	43	1	164	49	1	2	3	1	10	10	413		2	2
31	26326	38	2	158	45	1	0	1	1	9	10	247		2	2
32	23745	19	1	167	54	1	0	1	1	10	11	249		2	2
33	38891	29	1	167	57	1	0	1	1	11	10	266		2	2
34	49516	54	2	152	59	1	0	1	1	8	10	239		2	2
35	34989	23	2	160	54	1	1	2	1	9	10	323		2	2
36	48896	16	2	160	49	1	0	1	1	7	11	245		2	2
37	48594	25	1	169	51	1	2	3	1	8	9	424		2	2
38	50722	40	2	158	58	1	0	1	1	10	12	253		2	2
39	53227	14	1	160	51	1	0	1	1	9	9	268		2	2
40	39361	35	1	165	55	1	0	1	1	10	10	267		2	2

DEPTH
19
17.3
13.5
15.7
14.3
18.1
20
18.2
18
18
16.4
18.2
18.1
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18.2
18.5
16
16.5
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13.6
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15.5

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